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Thermostat Wiring Explained

In this article, I am going to explain the function and wiring of the most common home climate control thermostats. This information is designed to help you understand the function of the thermostat to assist you when installing a new one, or replacing or upgrading an old one. We will focus mainly on the basics of home heating / cooling thermostats, and first of all, I will explain the function of them.

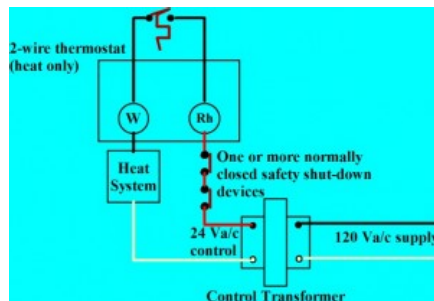
The thermostat is the control device that provides a simple user interface with the internal workings of your homes climate control system. By the use of an adjustable set-point, the job of the thermostat is to turn on either the heating or cooling system to maintain the desired room temperature in the home, and to turn off the system when the desired temperature is achieved.

The most basic of systems (such as an older 'heat only' forced air / gas furnace with a standing pilot light) only need two wires for control. They connect to a two-wire thermostat (generally a mechanical thermostat with a mercury filled ball connected to a coiled bi-metal strip).

A basic two-wire thermostat can be compared to a simple single-pole switch that you will find throughout your home, only instead of you turning the switch on and off as required, a mechanical or electronic temperature controlled mechanism is the operator of the switch.

The terminals are usually marked 'R' and 'W'. They usually operate at 24V ac power, and the source of this control power comes from a control transformer mounted either just outside, or inside the furnace body. The line voltage feeding the furnace (to operate the fan blower motor) is transformed down to a safer level of 24 volts (the gas control valve needs 24 volts to open), and after making a series loop through at least one safety device (the most basic and mandatory one is an over-temperature shut down), the power goes up to the thermostat, and when the room temperature falls below the set-point, the contacts close completing the circuit to the gas valve allowing it to open, the main burner to ignite, and begin the heating cycle.

In this the most basic of heating systems, as the temperature of the heat exchanger rises, another contact is closed on the line voltage side of the equation, and the fan blower motor starts moving air through the heat exchanger and out through the ducting in the home. If the fan fails to run for any reason, the heat exchanger will get too hot and the hi-limit temperature device will open the circuit to the gas valve, closing the valve and stopping the heat cycle.



If your home's system of this vintage has provisions for air-conditioning (cooling), then the thermostat wiring will have at least three wires (some will require a separate 'R' terminal for heating and cooling and will be labeled 'Rh' and 'Rc' now needing a minimum of 4 wires), 'R', 'W', and a 'Y' terminal.

When the mode is selected for cooling (basic heat / cool thermostats have a mode selector for either 'heat', 'cool', or 'auto') when the room temperature rises above the set-point, the thermostat will close the connection between the 'R' and the 'Y' terminals completing the circuit to the compressor and condenser unit that provides the cooling for the evaporator coils mounted in the discharge ducting of the system.

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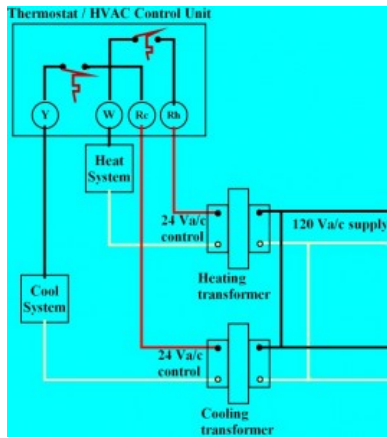
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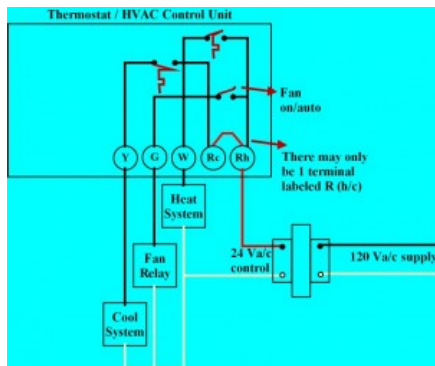
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The next step up from the older home systems was the introduction of the 'fan on / auto' switch. This function allows you to circulate the air in the house by using the fan in the furnace without heating or cooling the air moving through the system.

In the most basic system, this functionality is provided by use of a fan center relay, and the low voltage wiring to the thermostat now will require a minimum of three wires (for heat only units) and four wires (for heat / cool / fan) for control. This additional terminal is labeled 'G' in the thermostat.

When the 'fan on' setting is selected, the contacts between 'R' and 'G' are closed turning on the relay that powers the blower motor directly regardless of a call for heating or cooling.

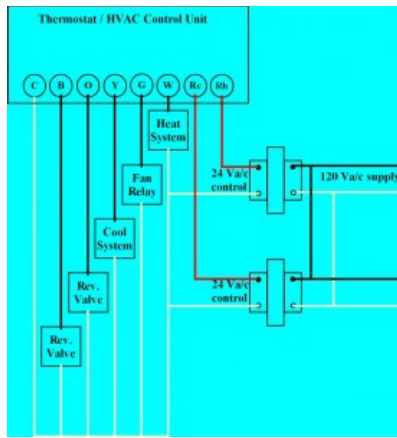


If you are replacing an old thermostat with a new digital thermostat, the electronics in these units may need yet another wire for a terminal labeled 'C'. This terminal is for a common connection from the control transformer that will provide steady 24 volt power between terminal 'R' and 'C' to power the thermostat itself.

If adding wires to your thermostat location is not possible, or very difficult, look for a thermostat that is battery powered which won't require the terminal 'C' for operation. The obvious down side of this is that if the battery goes dead the thermostat will no longer function.

Climate control systems have evolved a great deal in the last several years with the evolution of electronic control. This has made the units more efficient, with added safety features, and with this comes increased difficulty for the average home-owner to repair or replace any parts of the system that may break down (and they will, but only when you really need it!)

However, the terminals of the thermostats of today are still labeled the same, and provide the same functions as what we have discussed thus far. They just get a little more sophisticated so if you are pre-wiring a new home, check with the contractor providing the HVAC system as to what thermostat wiring is required. A new system may need as many as ten wires (like a two-stage heat, two-stage cooling system, heat pump reversing valves, fan control, etc.)



If the system had two-stage heating, and/or cooling, the 2nd stage terminals would be labelled W1 and W2 for heating, Y1 and Y2 for cooling. These additional terminals are not shown in this diagram

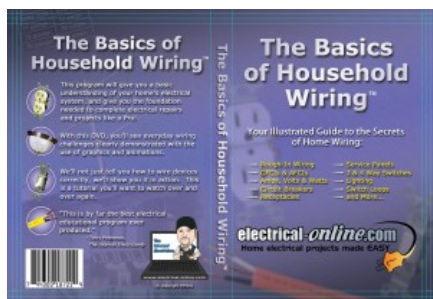
Now that you are armed with a basic understanding of the temperature control system in your home, you should now be able to identify what kind of system you have, and what type of functions you will need if replacing or up-grading your existing thermostat.

I hope this article helped with your question about thermostat wiring. Thanks for taking the time to read it! If you have any questions or comments on your furnace situation, feel free to add a comment below.

Not sure about doing this type of project yourself? Not anymore!

Have you been stumped by a three-way switch, struggled installing a new receptacle, or basically put off doing any wiring project yourself because you didn't feel confident working around electricity? I completely understand. Electricity can be downright scary. However, armed with the **proper information** you **must have** to work safely and completely, home owners like yourself **CAN** complete most simple home wiring projects.

Rather than scour the internet looking for the information you need to work on a wiring project or problem, I can recommend a tremendous resource that pulls together virtually everything you will need to know. I don't endorse many projects, but this is one that I fully endorse – "The Basics of Household Wiring" DVD or e-book.



As I licensed, journey man electrician, I have pretty high expectations for a DIY resource. It must be professional, it must be technically correct, and above all, it must focus on safety. I found all of that in this DVD, and I am confident that you will be impressed with the quality of the information contained in this excellent resource.

This easy to understand tutorial (and no – you won't need to understand technical "jargon") breaks down the majority of home wiring projects you'll encounter around the house and provides detailed, step-by-step instructions on how to complete them – **safely and competently**. This comprehensive, professionally produced DVD will give you the confidence you need to work on any of those home wiring projects! It's a tool that I recommend every DIYer consider adding to their tool box! [Click here for more information.](#)

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OR SIGN UP WITH DISQUS Name **Tracy** • 7 years ago

I have installed a new thermostat and my heat will come on like its supposed to but will not go off when it reaches temperature, any suggestions ?

181 ^ | v 4 • Reply • Share ›

**stephen** • 6 years ago

i installed a new honeywell thermostat. it had places for red white green yellow and left it set to use orange wire. i have no place for blue. everything works but i have no heat

54 ^ | v 5 • Reply • Share ›

**ivailosavoff** • 6 years ago

Hello ,

I have an old electric furnace with AT72H Honeywell control center and 2 wire thermostat. Now I have replaced the old thermostat with a nest one. I replaced the wire with 18/8 just in case and my question is can and should I plug in the G terminal on both thermostat and on the control fan center!

Now with 2 wires when I turn on the furnace the fan kick in and works non stop!

Thank you in advance!

39 ^ | v 3 • Reply • Share ›

**Tom** • 6 years ago

My thermostat display is out and my blower is on continuously (cold air no flame). i checked voltage at the thermostat and it was 13v. same at the output of the control board. the voltage at the secondary windings of the transformer is 24v. does this mean my circuit control board is bad?

14 ^ | v • Reply • Share ›

**Mike** • 8 years ago

I have installed a new thermostat and my fan is running all of the time in heat mode.

Old - TotallineP474-2150

New - Honeywell Vision pro 8000

66 ^ | v 11 • Reply • Share ›

**gas furnace** • 9 years ago

Hi,

Very informative and the usable blog..really glad to read it..thanks for sharing the information....

9 ^ | v • Reply • Share ›

**Malky** • 6 years ago

I want to replace an old Honeywell analog thermostat with a new programmable one. When I unscrewed the old one from the wall, there are only 2 WHITE wires coming out of the wall and into the back of the thermostat!! There are no markings on the rear of the back plate to indicate which one is red and which is truly white!!

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